

Digital Signal Processing Lab



Introduction

Dr. Konstantinos Karampidis

Grades

- ✓ 100% Exercises – 2 sets of exercises (each must be graded with at least 1). If you don't submit both exercises, the lab is considered failed.
- ✓ No extension is given on delivery dates of the exercises!!!
- ✓ Implementation with **Jupyter Notebooks**.
- ✓ The exercises will be delivered strictly through **eclass!!!** Exercises sent to my email will be rejected.
- ✓ Those who copy an exercise, they fail the lab immediately.
- ✓ Individual submissions only!!!
- ✓ For any subject concerning the lab, you may contact me through email: **karampidis@hmu.gr**

Anaconda

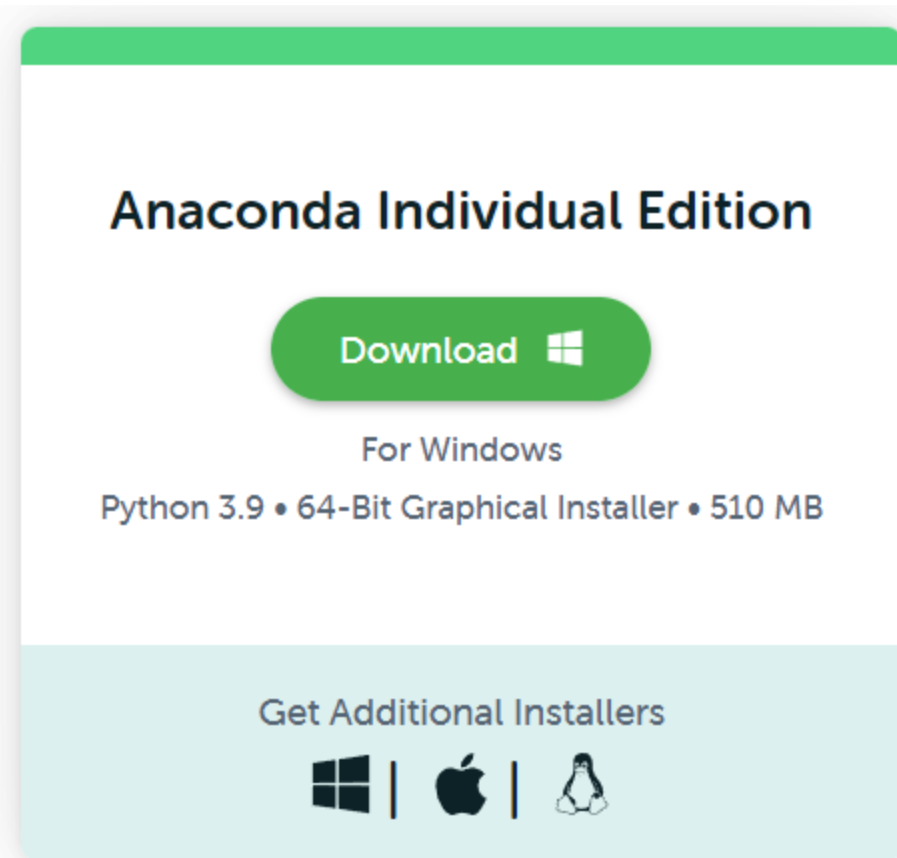
[Anaconda](#) is a Python distribution. A Python distribution provides the Python interpreter, together with a set of Python packages and sometimes other related tools, such as editors.

Why Anaconda ?

- The open-source [Anaconda Distribution](#) is the easiest way to perform Python/R data science and machine learning on Linux, Windows, and Mac OS X. With over 19 million users worldwide, it is the industry standard for developing, testing, and training on a single machine, enabling *individual data scientists* to:
- Quickly download 7,500+ Python/R data science packages
- Manage libraries, dependencies, and environments with [Conda](#)
- Develop and train machine learning and deep learning models with [scikit-learn](#), [TensorFlow](#), and [Theano](#)
- Analyze data with scalability and performance with [Dask](#), [NumPy](#), [pandas](#), and [Numba](#)
- Visualize results with [Matplotlib](#), [Bokeh](#), [Datashader](#), and [Holoviews](#)

Anaconda Installation

- Visit <https://www.anaconda.com/distribution/> and download the installer that corresponds to the operating system you are using
- Make sure you choose the latest Python version & 64-bit Graphical Installer



Anaconda

After installing and executing the program you will see this:

The screenshot displays the Anaconda Navigator desktop application. The interface includes a top menu bar with 'File' and 'Help', and a 'Sign in to Anaconda Cloud' button. A left sidebar contains navigation options: Home, Environments, Learning, and Community. The main area shows a grid of application cards under the heading 'Applications on base (root) Channels'. Each card features an icon, the application name, version number, a brief description, and a button to either 'Launch' or 'Install' the application.

Application	Version	Description	Action
JupyterLab	1.1.4	An extensible environment for interactive and reproducible computing, based on the Jupyter Notebook and Architecture.	Launch
Jupyter Notebook	6.0.1	Web-based, interactive computing notebook environment. Edit and run human-readable docs while describing the data analysis.	Launch
Qt Console	4.5.5	PyQt GUI that supports inline figures, proper multiline editing with syntax highlighting, graphical calltips, and more.	Launch
Spyder	3.3.6	Scientific PYTHON Development Environment. Powerful Python IDE with advanced editing, interactive testing, debugging and introspection features	Launch
Glueviz	0.15.2	Multidimensional data visualization across files. Explore relationships within and among related datasets.	Install
Orange 3	3.23.1	Component based data mining framework. Data visualization and data analysis for novice and expert. Interactive workflows with a large toolbox.	Install
RStudio	1.1.456	A set of integrated tools designed to help you be more productive with R. Includes R essentials and notebooks.	Install
VS Code	1.41.1	Streamlined code editor with support for development operations like debugging, task running and version control.	Install

At the bottom of the sidebar, there are links for 'Documentation' and 'Developer Blog', and social media icons for Twitter, YouTube, and GitHub.

Anaconda Installation

Depending on your operating system you can find a detailed installation guide below

[Windows](#)

[Linux](#)

[macOS](#)

Anaconda Environments

Navigator uses conda to create separate environments containing files, packages, and their dependencies that will not interact with other environments.

Create a new environment named snowflakes and install a package in it:

In Navigator, click the Environments tab, then click the Create button. The Create new environment dialog box appears.

In the Environment name field, type a descriptive name for your environment.

Note that in this step you will choose the Python version you want to use. Therefore, you can have environments with different versions of Python according to your needs.

Also, you can choose to install R instead of Python.

Anaconda Environments

Create new environment X

Name:

Location: *C:\Users\builder\Anaconda3\envs\snowflakes*

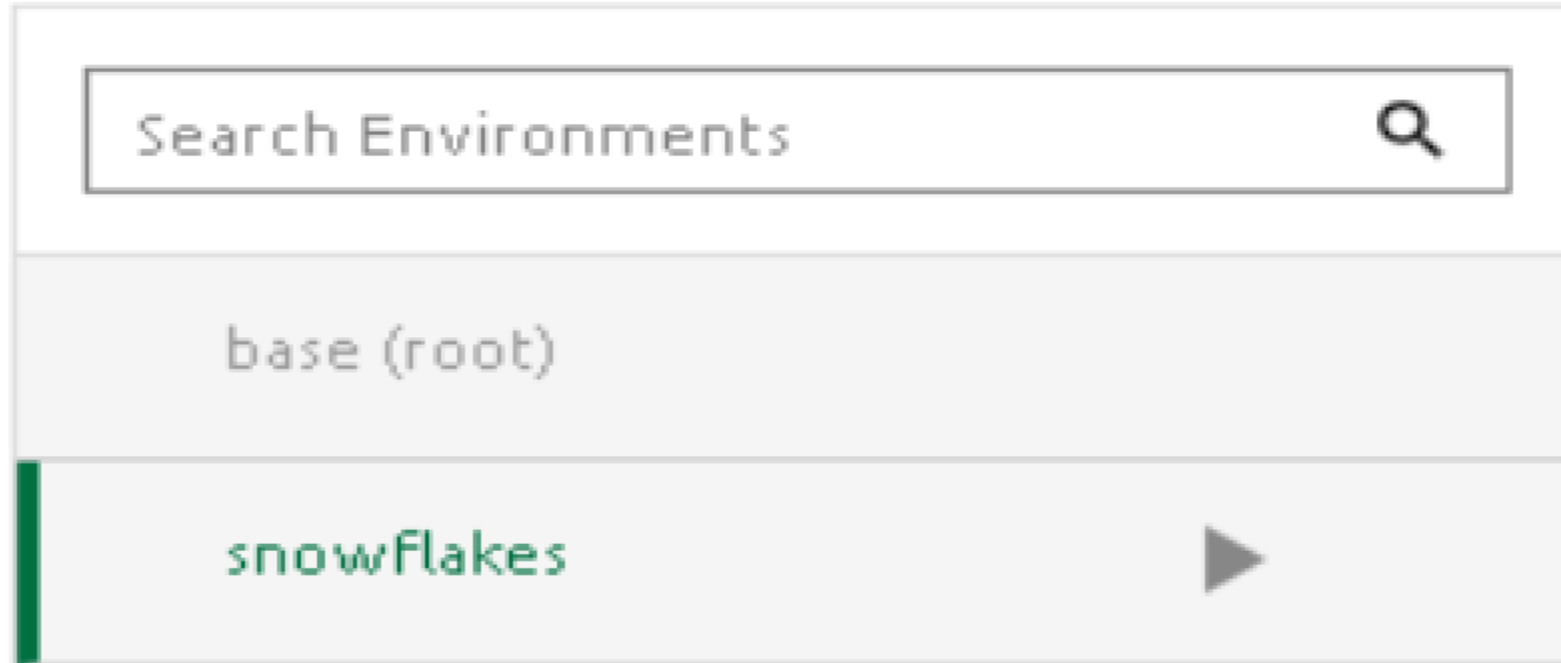
Packages:

Python v

R v

Anaconda Environments

Click Create. Navigator creates the new environment and activates it.



Now you have two environments, the default environment base (root), and snowflakes.

Switch between them (activate and deactivate environments) by clicking the name of the environment you want to use.

Return to the other environment by clicking its name.

Anaconda Environments

Managing packages

In this section, you check which packages you have installed, check which are available, and look for a specific package and install it.

To find a package you have already installed, click the name of the environment you want to search. The installed packages are displayed in the right panel.

You can change the selection of packages displayed in the right panel at any time by clicking the drop-down box above it and selecting Installed, Not Installed, Updatable, Selected, or All.

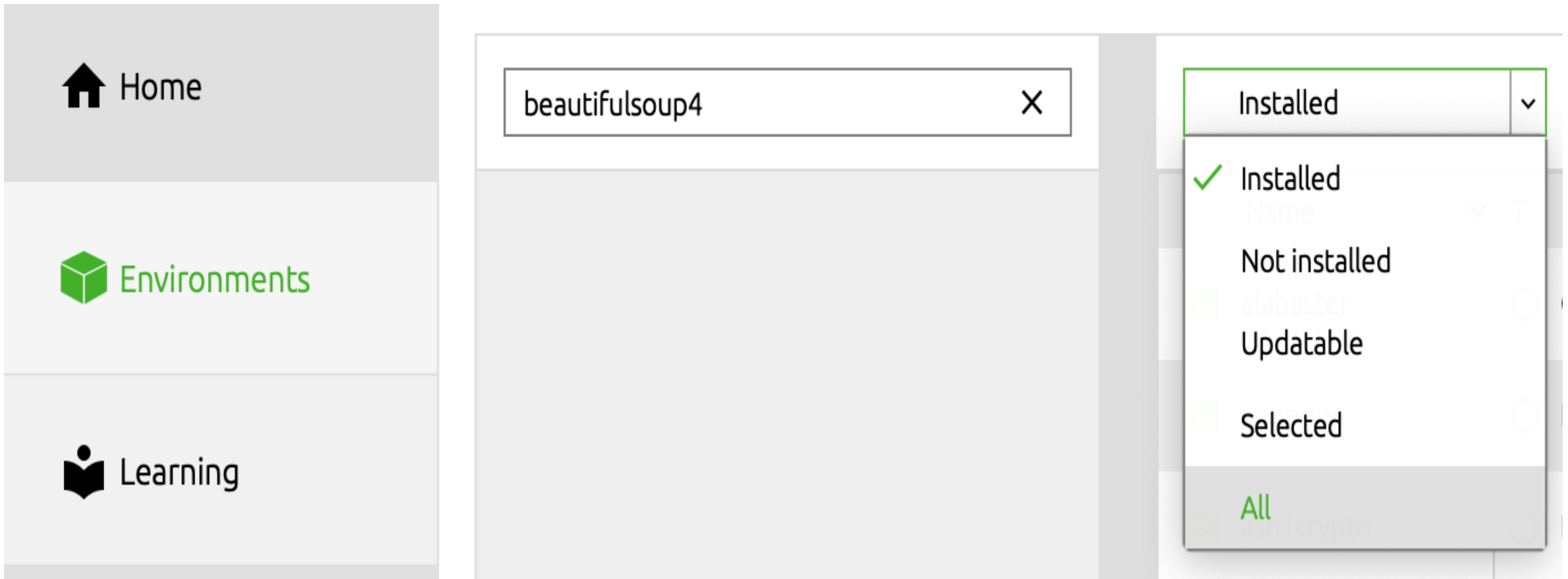
Anaconda Enviroments

The screenshot shows the Anaconda Environments interface. At the top, there is a filter dropdown menu currently set to "Installed". Below the dropdown, there are buttons for "Channels" and "Update index...", and a search bar labeled "Search Packages" with a magnifying glass icon. The main area displays a list of packages with columns for "Name", "Description", and "Status".

Name	Description	Status
alabaster	Configurable, python 2+3 compatible sphinx theme.	<input type="checkbox"/>
	Disable app nap on os x 10.9	<input type="checkbox"/>
asn1crypto	Python asn.1 library with a focus on performance and a pythonic api	<input type="checkbox"/>

Anaconda Environments

Check to see if a package you have not installed named “beautifulsoup4” is available from the Anaconda repository (must be connected to the Internet). On the Environments tab, in the Search Packages box, type beautifulsoup4, and from the Search Subset box select All or Not Installed.



Anaconda Environments

To install the package into the current environment, check the checkbox next to the package name, then click the bottom Apply button.

Not installed Channels Update index...

Name	T	Description	Version
<input type="checkbox"/> _ipyw_jlab_nb_ex...		A configuration metapackage for enabling anaconda-bundled jupyter extensions	0.1.0
<input checked="" type="checkbox"/> _mutex_mxnet			0.0.40
<input type="checkbox"/> _nb_ext_conf			0.4.0
<input type="checkbox"/> _py-xgboost-mutex			2.0
<input checked="" type="checkbox"/> _r-mutex			1.0.0
<input type="checkbox"/> _r-xgboost-mutex			2.0
<input type="checkbox"/> _tflow_1100_select			0.0.2

1783 packages available 2 packages selected Apply Clear

Jupyter Notebook

The Jupyter Notebook is an interactive programming environment , in which you can combine Python code and execution results with annotations, equations, figures, links, etc.

The Jupyter Notebook will run in the internet browser of our computer and does not require internet access, it will access to our local files via the browser interface.

Notebooks are similar to Word documents, and we can edit them interactively in the internet browser. Notebooks are saved in its own format with the '. ipynb extension, but can be also downloaded as PDFs, HTML pages or Python code.

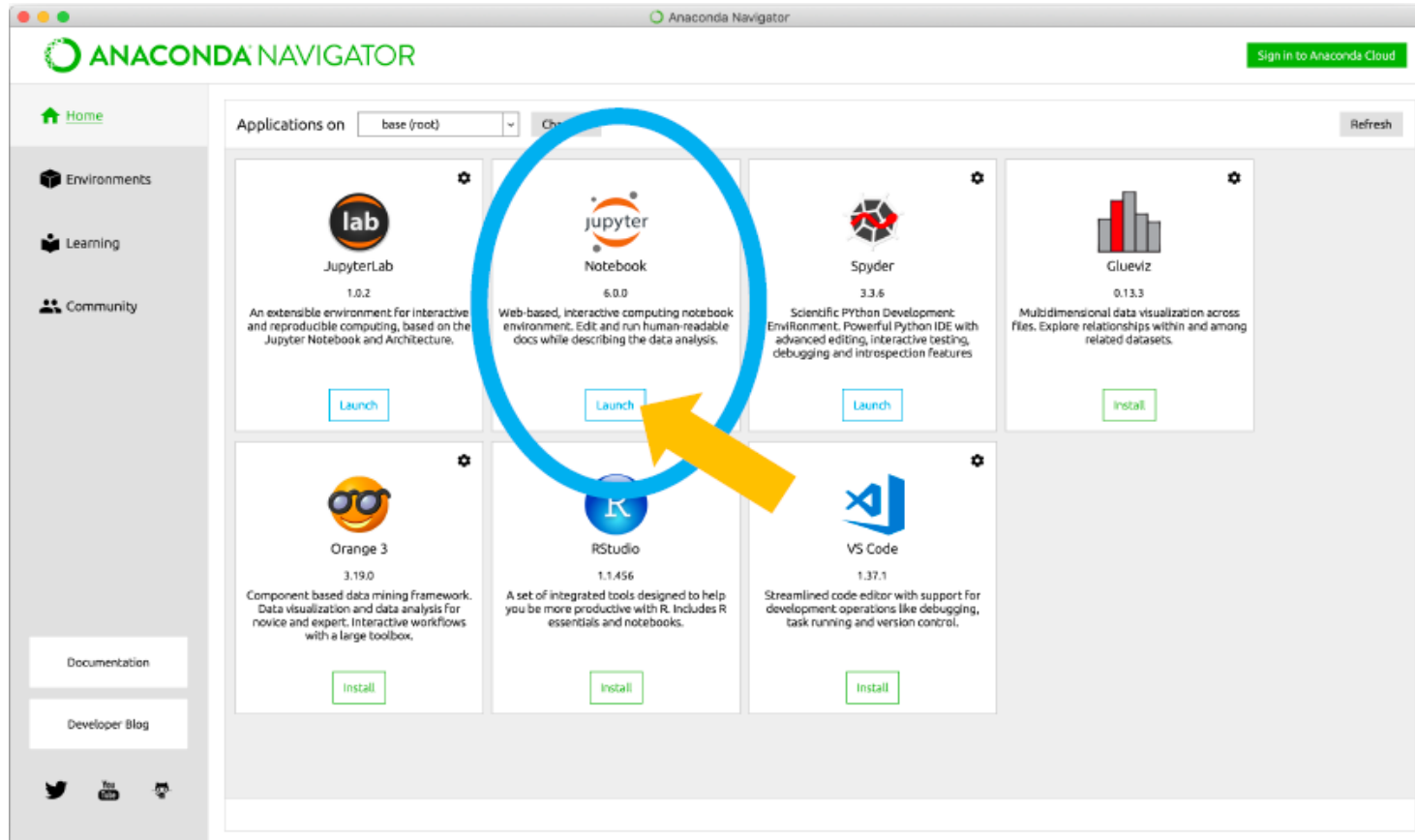
Jupyter Notebook

There are 3 ways to launch a Jupyter Notebook:

1) Using Anaconda Navigator

a) Open the application called Anaconda Navigator

b) Click on “Launch” in the Jupyter Notebook box



Jupyter Notebook

2) Using Anaconda Prompt

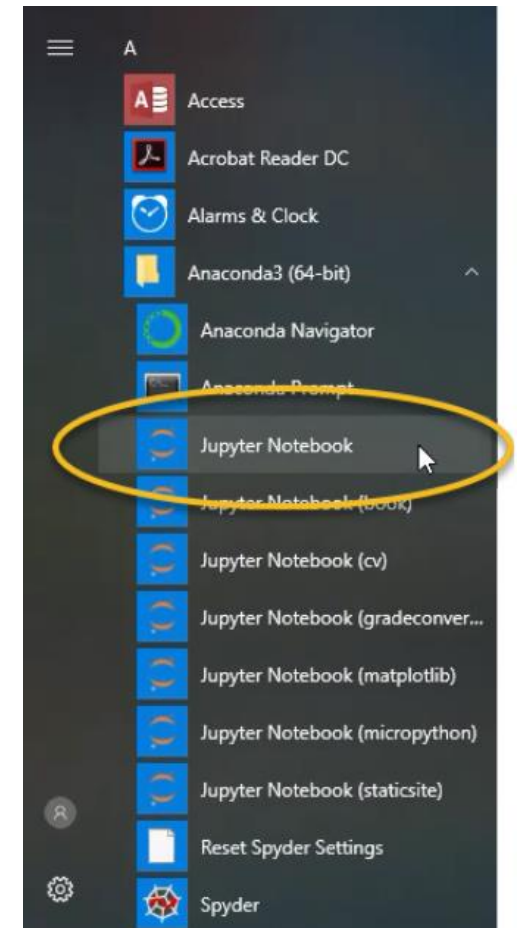
a) Open the application called Anaconda Prompt

b) Type “jupyter notebook” (without quotes) and hit the return key

3) Clicking on the Jupyter Notebook App in the Start Menu

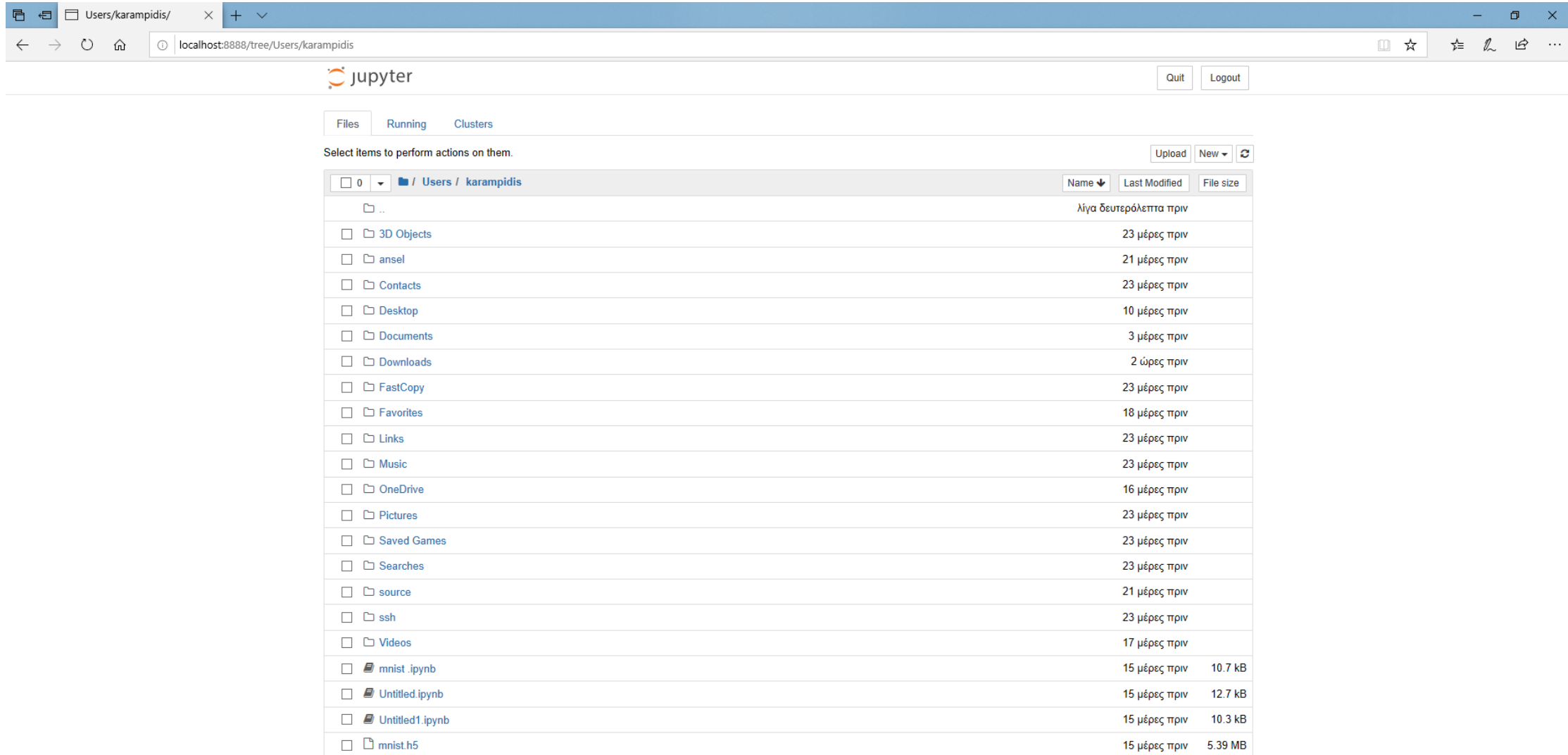


```
Anaconda Prompt (anaconda3)
(base) C:\>jupyter notebook
```



Jupyter Notebook

You must see a page similar to this



The screenshot shows a web browser window with the address bar displaying 'localhost:8888/tree/Users/karampidis'. The page title is 'jupyter' and there are 'Quit' and 'Logout' buttons in the top right. Below the navigation tabs (Files, Running, Clusters), there is a prompt 'Select items to perform actions on them.' and buttons for 'Upload', 'New', and a refresh icon. The main content is a file browser table for the directory '/ Users / karampidis'. The table has columns for 'Name', 'Last Modified', and 'File size'. It lists various system folders like '3D Objects', 'Desktop', and 'Downloads', along with Jupyter Notebook files like 'mnist.ipynb' and 'Untitled1.ipynb'.

<input type="checkbox"/>	0	Name	Last Modified	File size
<input type="checkbox"/>		..	λίγα δευτερόλεπτα πριν	
<input type="checkbox"/>		3D Objects	23 μέρες πριν	
<input type="checkbox"/>		ansel	21 μέρες πριν	
<input type="checkbox"/>		Contacts	23 μέρες πριν	
<input type="checkbox"/>		Desktop	10 μέρες πριν	
<input type="checkbox"/>		Documents	3 μέρες πριν	
<input type="checkbox"/>		Downloads	2 ώρες πριν	
<input type="checkbox"/>		FastCopy	23 μέρες πριν	
<input type="checkbox"/>		Favorites	18 μέρες πριν	
<input type="checkbox"/>		Links	23 μέρες πριν	
<input type="checkbox"/>		Music	23 μέρες πριν	
<input type="checkbox"/>		OneDrive	16 μέρες πριν	
<input type="checkbox"/>		Pictures	23 μέρες πριν	
<input type="checkbox"/>		Saved Games	23 μέρες πριν	
<input type="checkbox"/>		Searches	23 μέρες πριν	
<input type="checkbox"/>		source	21 μέρες πριν	
<input type="checkbox"/>		ssh	23 μέρες πριν	
<input type="checkbox"/>		Videos	17 μέρες πριν	
<input type="checkbox"/>		mnist.ipynb	15 μέρες πριν	10.7 kB
<input type="checkbox"/>		Untitled.ipynb	15 μέρες πριν	12.7 kB
<input type="checkbox"/>		Untitled1.ipynb	15 μέρες πριν	10.3 kB
<input type="checkbox"/>		mnist.h5	15 μέρες πριν	5.39 MB

Jupyter Notebook

- Navigate through your folders until you get to the directory you want to save your notebooks.
- Open a new Notebook file by clicking on the “New” menu on the upper right



Quit

Logout

Files

Running

Clusters

Select items to perform actions on them.

Upload

New



<input type="checkbox"/> 0	Name	
<input type="checkbox"/>	/ Users / karampidis	
<input type="checkbox"/>	..	
<input type="checkbox"/>	3D Objects	
<input type="checkbox"/>	ansel	
<input type="checkbox"/>	Contacts	
<input type="checkbox"/>	Desktop	10 μέρες πριν
<input type="checkbox"/>	Documents	3 μέρες πριν

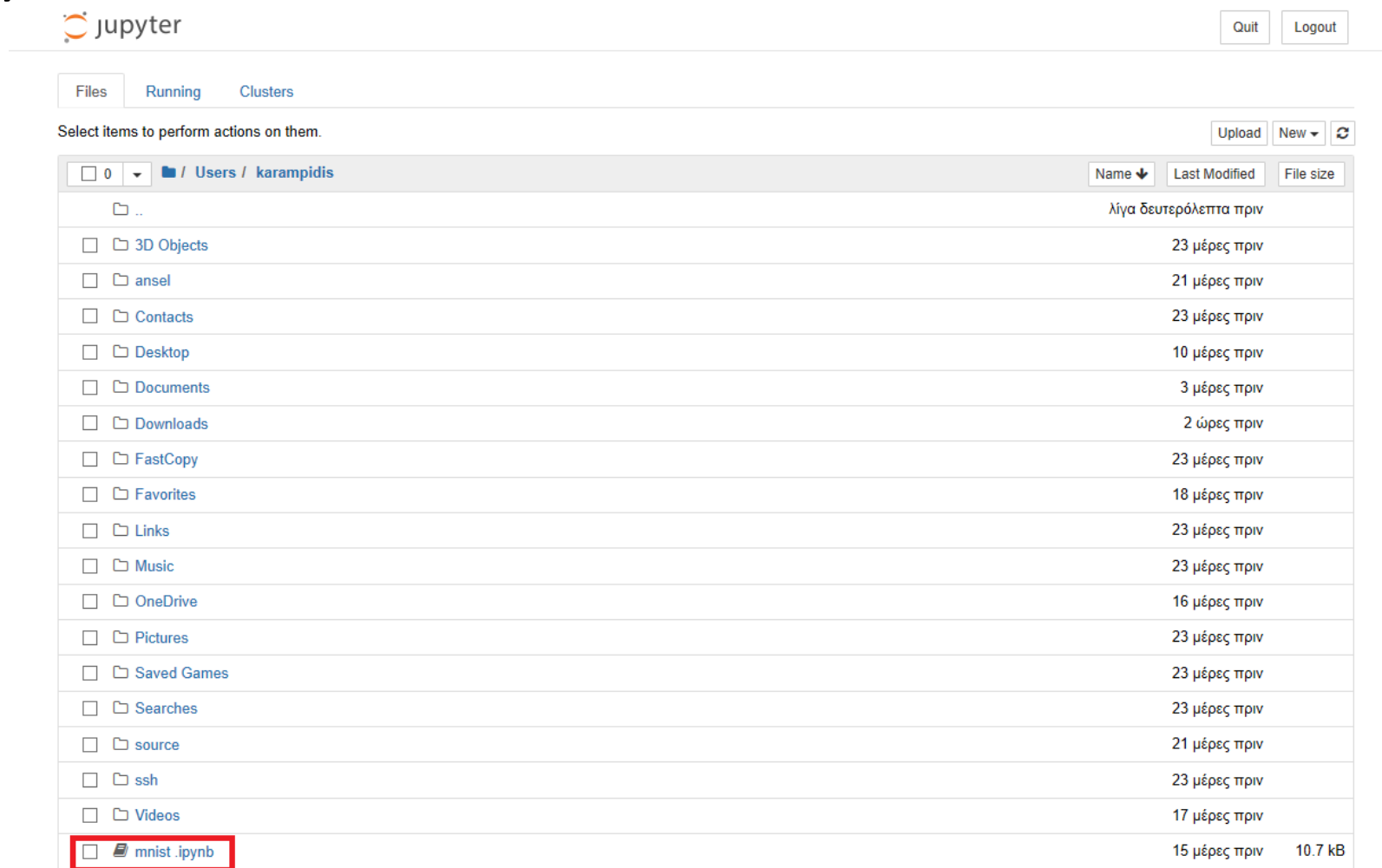
Notebook:
Python 3

Other:
Text File
Folder
Terminal

Jupyter Notebook

Open a previously saved Notebook file by clicking on the name of the file.

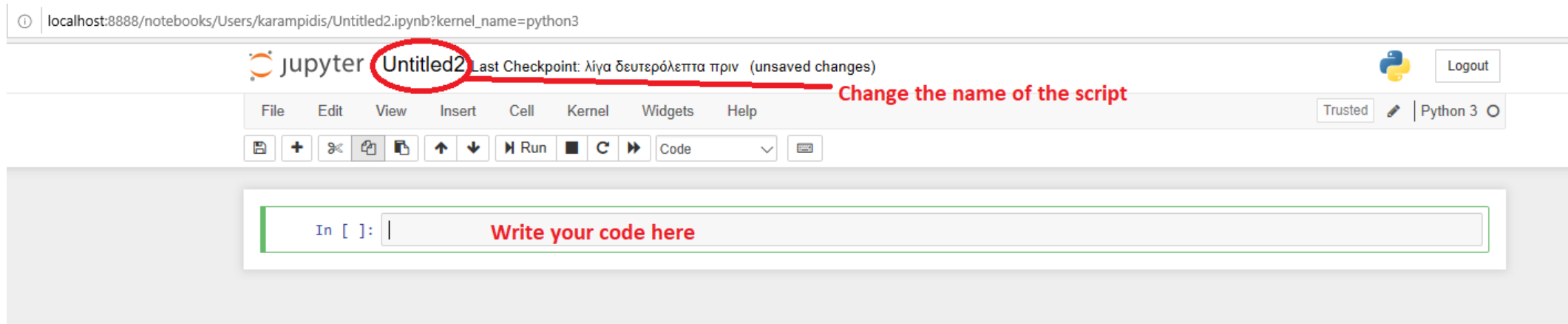
The extension for a Jupyter Notebook file is “.ipynb”, which is short for “interactive python notebook”



The screenshot shows the Jupyter Notebook interface. At the top left is the Jupyter logo. On the top right are 'Quit' and 'Logout' buttons. Below the logo are tabs for 'Files', 'Running', and 'Clusters'. A message says 'Select items to perform actions on them.' with 'Upload', 'New', and a refresh icon. The main area shows a file browser for the user 'karampidis'. It lists various folders and files. The file 'mnist.ipynb' is highlighted with a red box. The file size is 10.7 kB and it was modified 15 days ago.

	Name	Last Modified	File size
<input type="checkbox"/>	0		
<input type="checkbox"/>	..	λίγα δευτερόλεπτα πριν	
<input type="checkbox"/>	3D Objects	23 μέρες πριν	
<input type="checkbox"/>	ansel	21 μέρες πριν	
<input type="checkbox"/>	Contacts	23 μέρες πριν	
<input type="checkbox"/>	Desktop	10 μέρες πριν	
<input type="checkbox"/>	Documents	3 μέρες πριν	
<input type="checkbox"/>	Downloads	2 ώρες πριν	
<input type="checkbox"/>	FastCopy	23 μέρες πριν	
<input type="checkbox"/>	Favorites	18 μέρες πριν	
<input type="checkbox"/>	Links	23 μέρες πριν	
<input type="checkbox"/>	Music	23 μέρες πριν	
<input type="checkbox"/>	OneDrive	16 μέρες πριν	
<input type="checkbox"/>	Pictures	23 μέρες πριν	
<input type="checkbox"/>	Saved Games	23 μέρες πριν	
<input type="checkbox"/>	Searches	23 μέρες πριν	
<input type="checkbox"/>	source	21 μέρες πριν	
<input type="checkbox"/>	ssh	23 μέρες πριν	
<input type="checkbox"/>	Videos	17 μέρες πριν	
<input type="checkbox"/>	mnist.ipynb	15 μέρες πριν	10.7 kB

Jupyter Notebook



The screenshot displays the Jupyter Notebook interface. At the top, the browser address bar shows the URL: localhost:8888/notebooks/Users/karampidis/Untitled2.ipynb?kernel_name=python3. The Jupyter logo is on the left, followed by the notebook title "Untitled2" which is circled in red. To the right of the title, it says "Last Checkpoint: λίγα δευτερόλεπτα πριν (unsaved changes)". A red arrow points from the circled title to the text "Change the name of the script". On the far right, there is a Python logo and a "Logout" button. Below the title bar is a menu bar with "File", "Edit", "View", "Insert", "Cell", "Kernel", "Widgets", and "Help". Underneath the menu is a toolbar with icons for saving, adding, deleting, copying, pasting, undo, redo, and running. A dropdown menu is set to "Code". Below the toolbar is a code cell with the prompt "In []:" and a text input field containing the red text "Write your code here".

In a jupyter notebook you can have equations, text , code , plots etc.

Jupyter Notebook

jupyter spectrogram (autosaved)



File Edit View Insert Cell Kernel Help

Python 3



Simple spectral analysis

An illustration of the [Discrete Fourier Transform](#)

$$X_k = \sum_{n=0}^{N-1} x_n \exp^{-\frac{j2\pi}{N} kn} \quad k = 0, \dots, N-1$$

Equations

```
In [2]: from scipy.io import wavfile
rate, x = wavfile.read('test_mono.wav')
```

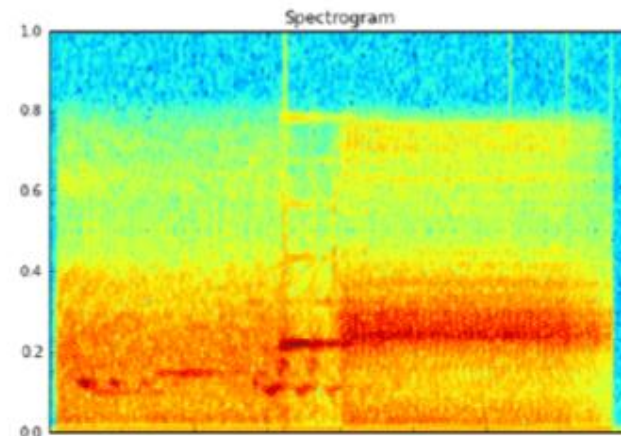
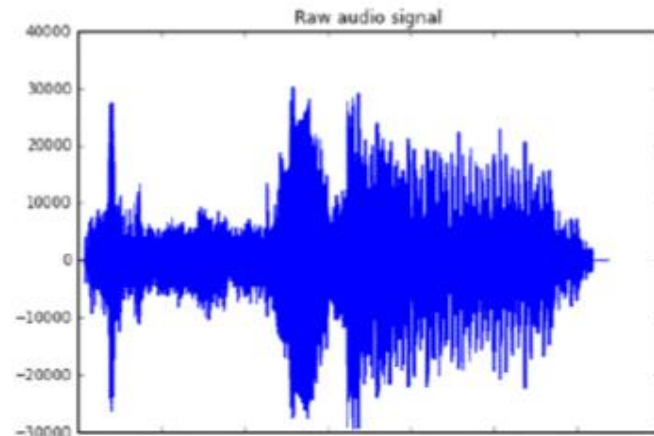
Code

And we can easily view it's spectral structure using matplotlib's builtin specgram routine:

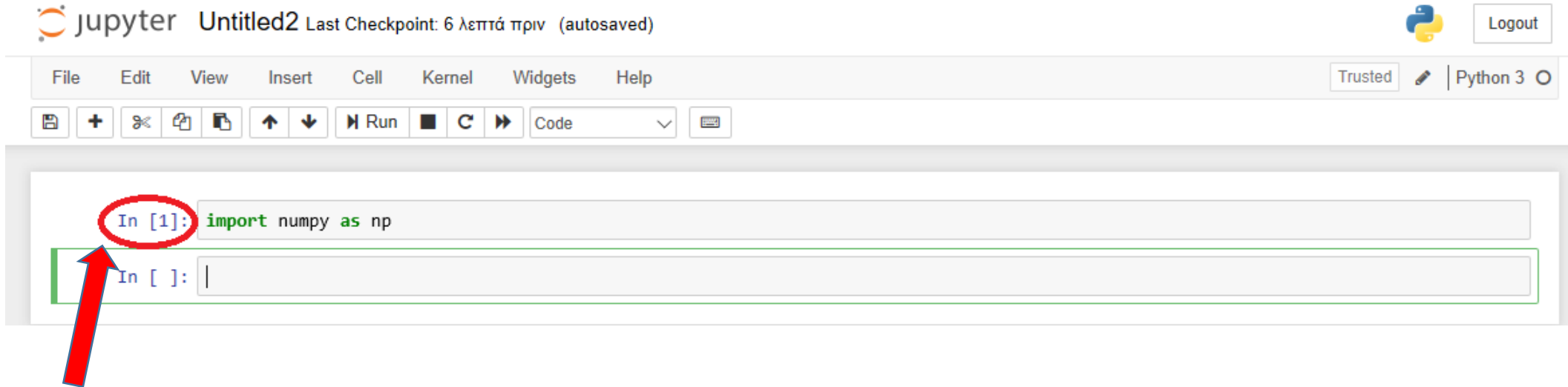
```
In [5]: fig, (ax1, ax2) = plt.subplots(1,2,figsize(16,5))
ax1.plot(x); ax1.set_title('Raw audio signal')
ax2.specgram(x); ax2.set_title('Spectrogram');
```

Text

Plots



Jupyter Notebook



The screenshot shows the Jupyter Notebook interface. At the top, the logo and text 'jupyter Untitled2 Last Checkpoint: 6 λεπτά πριν (autosaved)' are visible. To the right, there is a Python logo and a 'Logout' button. Below this is a menu bar with 'File', 'Edit', 'View', 'Insert', 'Cell', 'Kernel', 'Widgets', and 'Help'. On the right side of the menu bar, it says 'Trusted' and 'Python 3'. Below the menu bar is a toolbar with icons for saving, adding, deleting, copying, pasting, undo, redo, and running. The main area contains two code cells. The first cell is highlighted with a red circle around the text 'In [1]:' and contains the code `import numpy as np`. A red arrow points from the bottom left towards the 'In [1]:' text. The second cell is empty and contains 'In []: |'.

If there is a number , then the cell has been evaluated! This means that the code written in that cell has been run. A cell is evaluated by either clicking “Run” or by typing Shift+Return.

Environment Setup

In order to work flawlessly this semester you need to:

- Create a new environment
- Select the new environment and install these packages:
 - numpy
 - scikit-learn
 - matplotlib
 - scipy
 - pandas
 - seaborn

Environment Setup

Environment setup through Anaconda prompt

Open Anaconda prompt and issue the following commands:

```
conda create --name dsp
```

```
conda activate dsp
```

```
conda install numpy scikit-learn matplotlib pandas seaborn scipy
```

```
conda install jupyter
```

Thank you !!!